FINDINGS

Spot fires and topography interact to enhance fire rate of spread.

Effect of spot fires and topography on fire rate of spread: Combustion tunnel experiments

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Understanding the role of spot fires in the overall spread of a bushfire is vital if more accurate bushfire behaviour models are to be produced. To improve our understanding, we conducted a series of experiments at the Forest Fire Research Laboratory of the Association for the Development of Industrial Aerodynamics in Lousã, Portugal.

Introduction

Ignition of unburnt fuels by firebrands during bushfires creates spot fires: separate new fires ahead of the main fire line. These spot fires interact with the main fire and influence the overall or combined (i.e. main fire + spot fires) rate of spread in some way. We conducted experiments in a combustion wind tunnel to explore how spot fires influence rate of spread, and whether the effect differs between a flat fuel bed and a fuel bed with a hill present.

Methods

We conducted 30 experiments on a 3 m wide by 4 m long fuel bed in a combustion wind tunnel. For all experiments we ignited a fire line and had a 1.5 m/s wind pushing the fire through the fuel (pine needles). For some experiments we then manually ignited 1 or 2 small "spot fires" ahead of this fire line, while for the remaining experiments there were no spot fires ignited. For half of the experiments the fuel bed had a model hill installed and the other half of the experiments just had a flat fuel bed. We recorded the experiments and measured spread time and rate of spread at 3 different distance intervals (Figure 1).

Results

All our flat fuel bed experiments had similar rates of spread regardless of the number of spot fires ignited (i.e. spot fires had no significant effect on rate of spread). But for the experiments with the model hill, rate of spread was substantially different between spot fire levels, with the strength of the effect differing between measurement intervals. When a hill was present, zero spot fire experiments had the slowest spread, while one or two spot fire experiments had the fastest spread (depending on interval). See figure 1 for some results in seconds.

Discussion

The results suggest rate of spread can be significantly influenced by an interaction between spot fires and topography: spotting may increase rate of spread of bushfires in hilly areas but have only a minor effect on rate of spread in flat areas. Our results appeared to be mainly due to spot fires spreading back up the lee side of the hill (under influence of a lee slope eddy) to merge with and extend the main fire (top photo). This effect is important to explore further (e.g. with bushfire observations) as it could be incorporated into bushfire spread models to produce more accurate rate of spread predictions.

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Tables and figures

Above: Rate of spread experiment with a line fire spreading up a model hill towards two manually ignited spot fires on the lee side of the hill.

Above: Final stages of a rate of spread experiment with a line fire conducted on a flat fuel bed

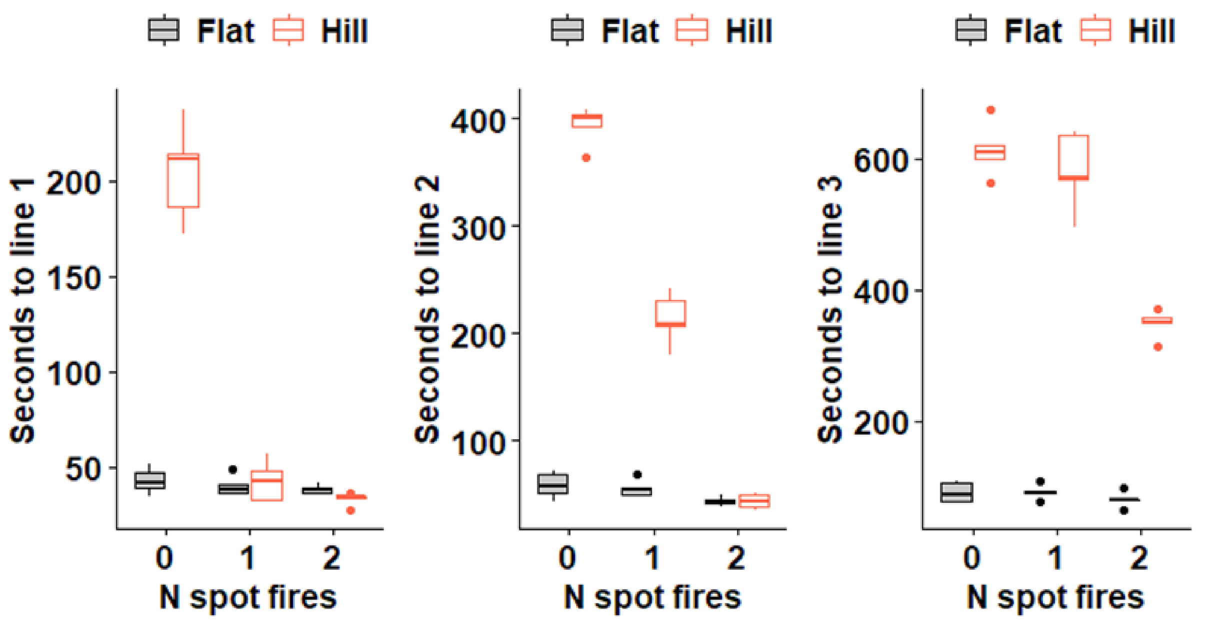

Figure1: Boxplots representing the time taken (seconds) for the main fire to cross three spread measurement intervals (line 1 225 cm, line 2 275 cm, line 3 350 cm downwind of the ignition line). If spot fires were separate, they were not included in the rate of spread measurement, but once the spot fires merged with the main fire, this was considered as the new main fire.

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